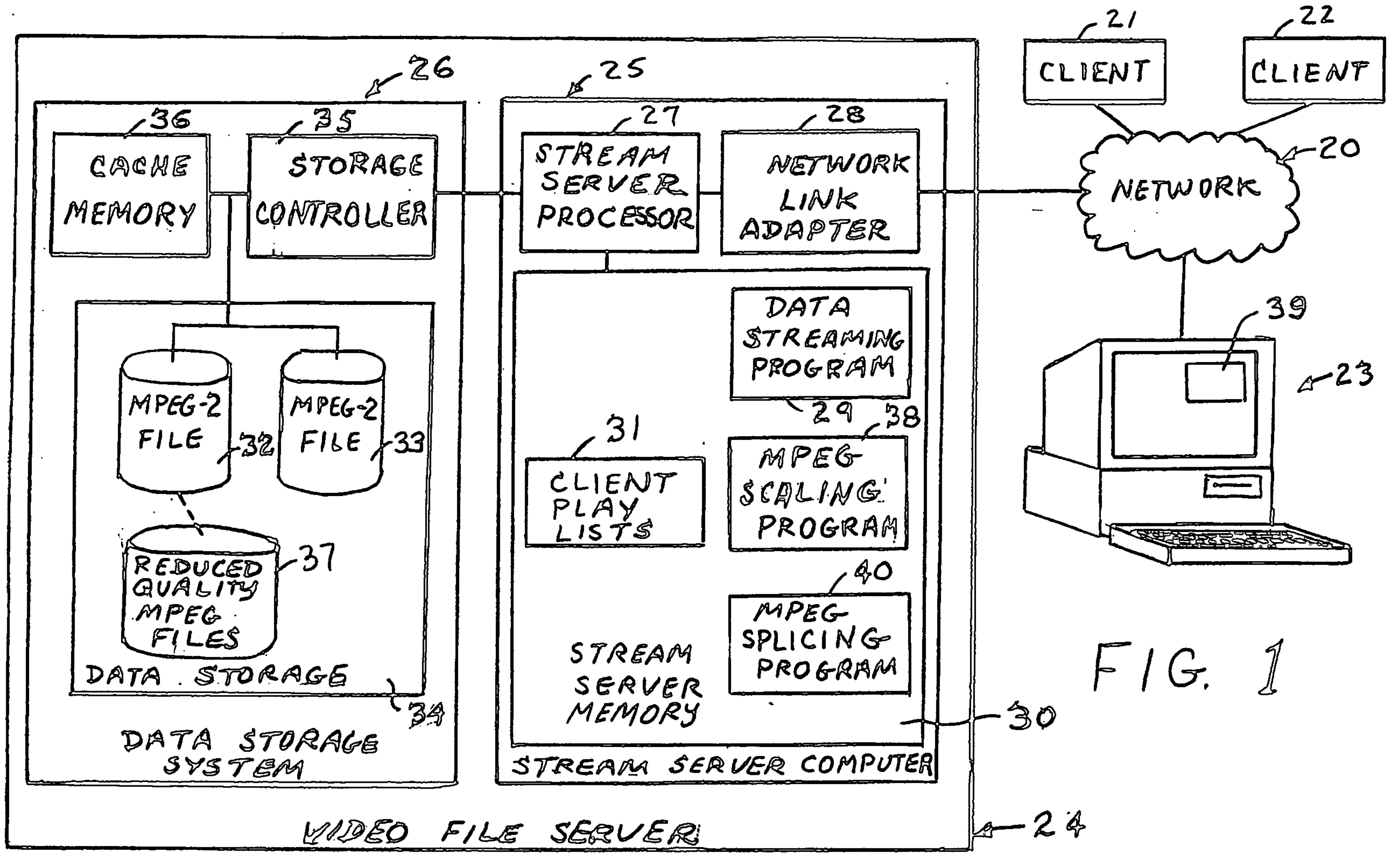
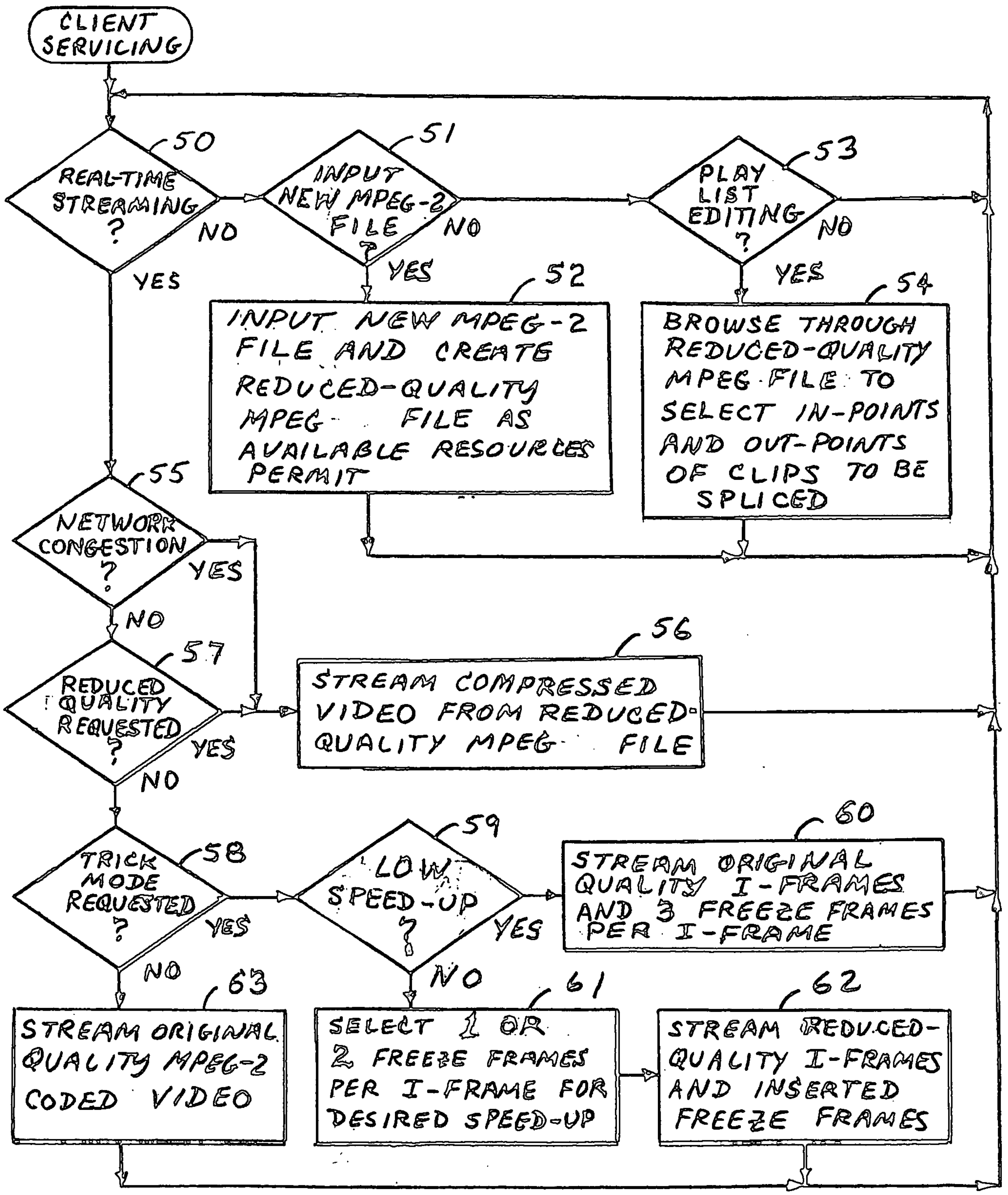


21
CLIENT
22
CLIENT
20
NETWORK
23
39
26
36
CACHE MEMORY
35
STORAGE CONTROLLER
MPEG-2 FILE
32
MPEG-2 FILE
33
REDUCED QUALITY MPEG FILES
37
DATA STORAGE
34
DATA STORAGE SYSTEM
25
27
STREAM SERVER PROCESSOR
28
NETWORK LINK ADAPTER
DATA STREAMING PROGRAM
29
38
MPEG SCALING PROGRAM
31
CLIENT PLAY LISTS
40
MPEG SPLICING PROGRAM
STREAM SERVER MEMORY
30
STREAM SERVER COMPUTER
VIDEO FILE SERVER
24

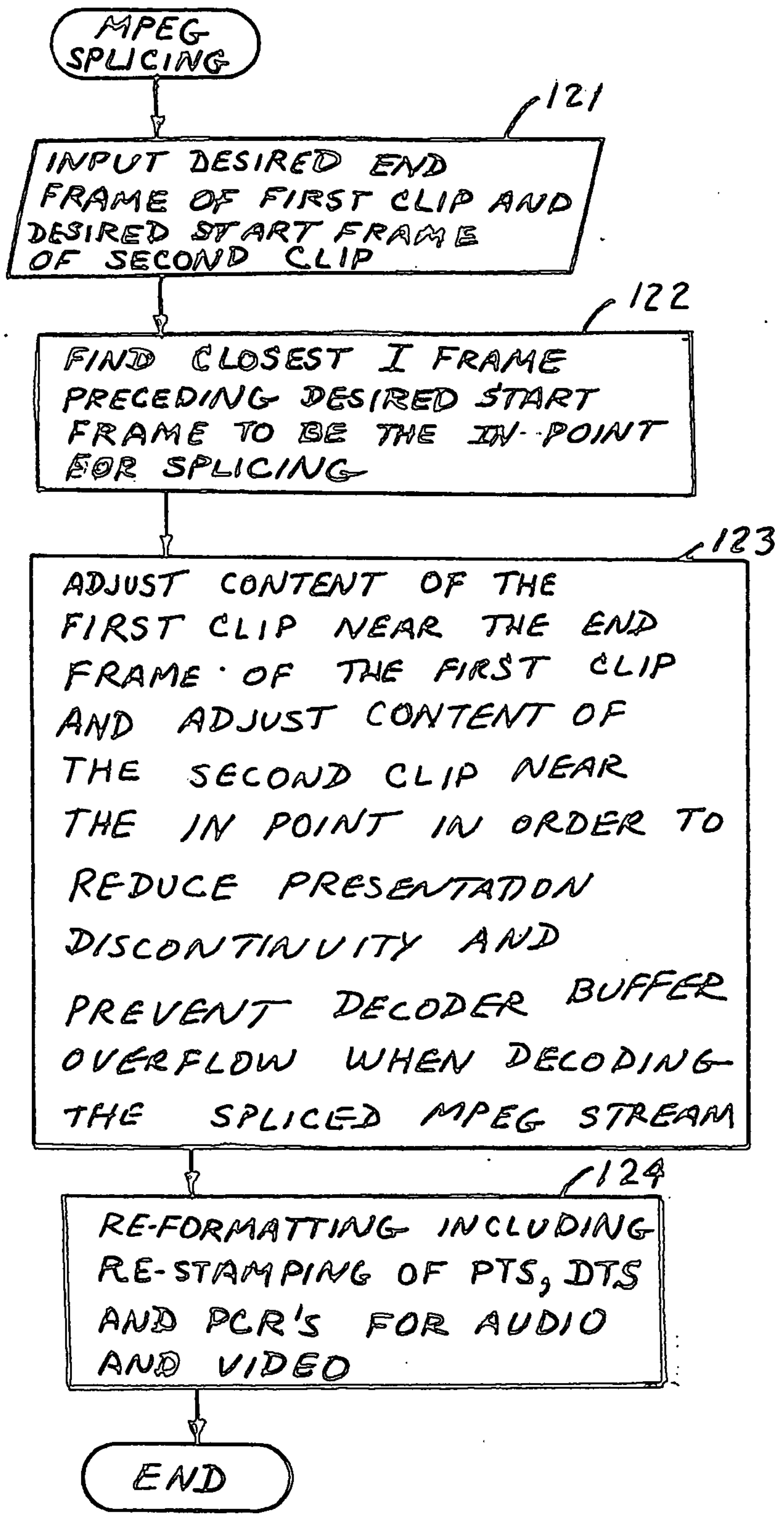
FIG. 1



CLIENT SERVICING
50
REAL-TIME STREAMING ?
NO
YES
51
INPUT NEW MPEG-2 FILE ?
NO
YES
52
INPUT NEW MPEG-2 FILE AND CREATE REDUCED-QUALITY MPEG FILE AS AVAILABLE RESOURCES PERMIT
53
PLAY LIST EDITING ?
NO
YES
54
BROWSE THROUGH REDUCED-QUALITY MPEG FILE TO SELECT IN-POINTS AND OUT-POINTS OF CLIPS TO BE SPLICED
55
NETWORK CONGESTION ?
YES
NO
57
REDUCED QUALITY REQUESTED ?
YES
NO
56
STREAM COMPRESSED VIDEO FROM REDUCED-QUALITY MPEG FILE
58
TRICK MODE REQUESTED ?
YES
NO
59
LOW SPEED-UP ?
YES
NO
60
STREAM ORIGINAL QUALITY I-FRAMES AND 3 FREEZE FRAMES PER I-FRAME
63
STREAM ORIGINAL QUALITY MPEG-2 CODED VIDEO
61
SELECT 1 OR 2 FREEZE FRAMES PER I-FRAME FOR DESIRED SPEED-UP
62
STREAM REDUCED-QUALITY I-FRAMES AND INSERTED FREEZE FRAMES

FIG. 2

00003060 "61680960



MPEG SPLICING
121
INPUT DESIRED END FRAME OF FIRST CLIP AND DESIRED START FRAME OF SECOND CLIP
122
FIND CLOSEST I FRAME PRECEDING DESIRED START FRAME TO BE THE IN-POINT FOR SPLICING
123
ADJUST CONTENT OF THE FIRST CLIP NEAR THE END FRAME OF THE FIRST CLIP AND ADJUST CONTENT OF THE SECOND CLIP NEAR THE IN POINT IN ORDER TO REDUCE PRESENTATION DISCONTINUITY AND PREVENT DECODER BUFFER OVERFLOW WHEN DECODING THE SPLICED MPEG STREAM
124
RE-FORMATTING INCLUDING RE-STAMPING OF PTS, DTS AND PCR'S FOR AUDIO AND VIDEO
END

FIG. 3

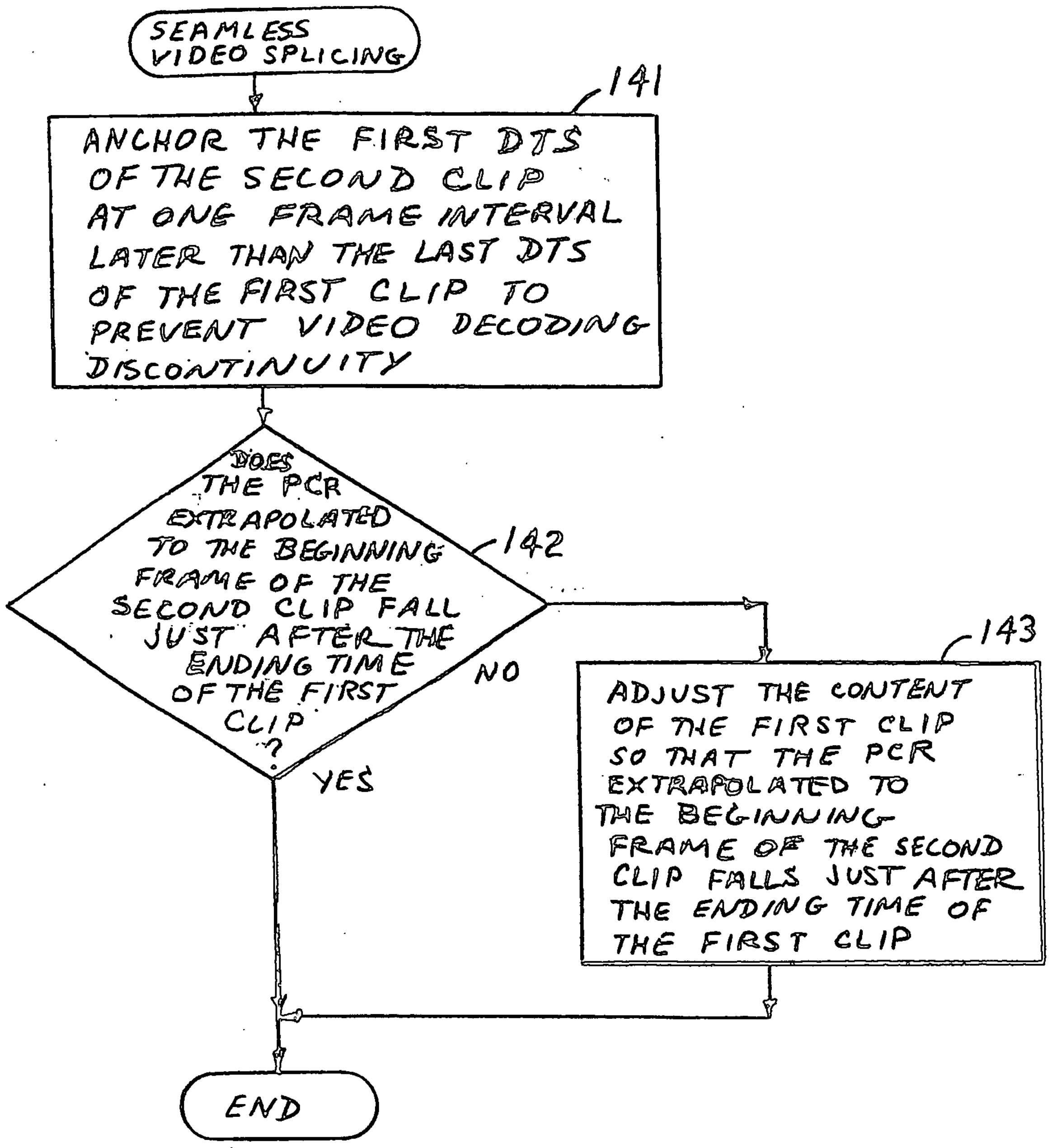

SEAMLESS VIDEO SPLICING
141
ANCHOR THE FIRST DTS OF THE SECOND CLIP AT ONE FRAME INTERVAL LATER THAN THE LAST DTS OF THE FIRST CLIP TO PREVENT VIDEO DECODING DISCONTINUITY
DOES THE PCR EXTRAPOLATED TO THE BEGINNING FRAME OF THE SECOND CLIP FALL JUST AFTER THE ENDING TIME OF THE FIRST CLIP ?
142
NO
YES
143
ADJUST THE CONTENT OF THE FIRST CLIP SO THAT THE PCR EXTRAPOLATED TO THE BEGINNING FRAME OF THE SECOND CLIP FALLS JUST AFTER THE ENDING TIME OF THE FIRST CLIP
END

FIG. 4

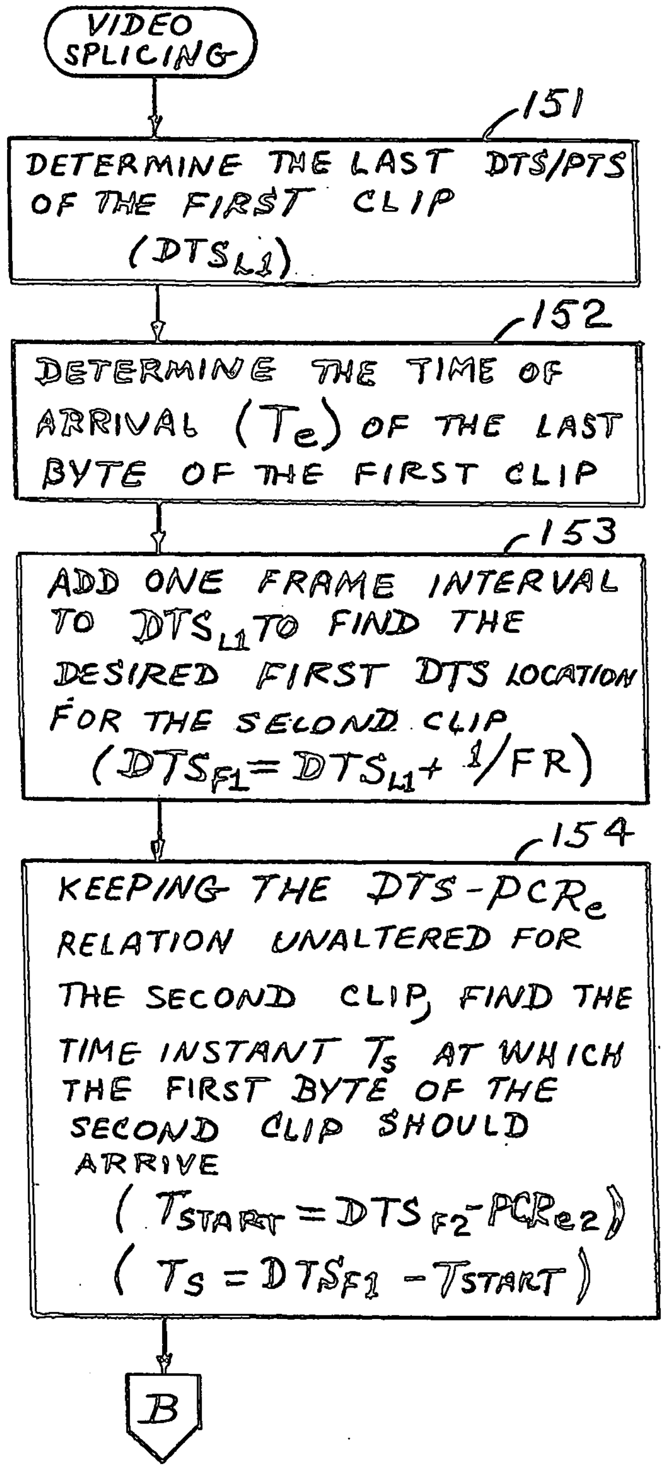

VIDEO SPLICING
151
DETERMINE THE LAST DTS/PTS OF THE FIRST CLIP (DTS_{L1})
152
DETERMINE THE TIME OF ARRIVAL (T_e) OF THE LAST BYTE OF THE FIRST CLIP
153
ADD ONE FRAME INTERVAL TO DTS_{L1} TO FIND THE DESIRED FIRST DTS LOCATION FOR THE SECOND CLIP ($DTS_{F1} = DTS_{L1} + 1/FR$)
154
KEEPING THE $DTS-PCR_e$ RELATION UNALTERED FOR THE SECOND CLIP, FIND THE TIME INSTANT T_s AT WHICH THE FIRST BYTE OF THE SECOND CLIP SHOULD ARRIVE
($T_{START} = DTS_{F2} - PCR_{e2}$)
($T_S = DTS_{F1} - T_{START}$)
B

FIG. 5

09603519 . 050300

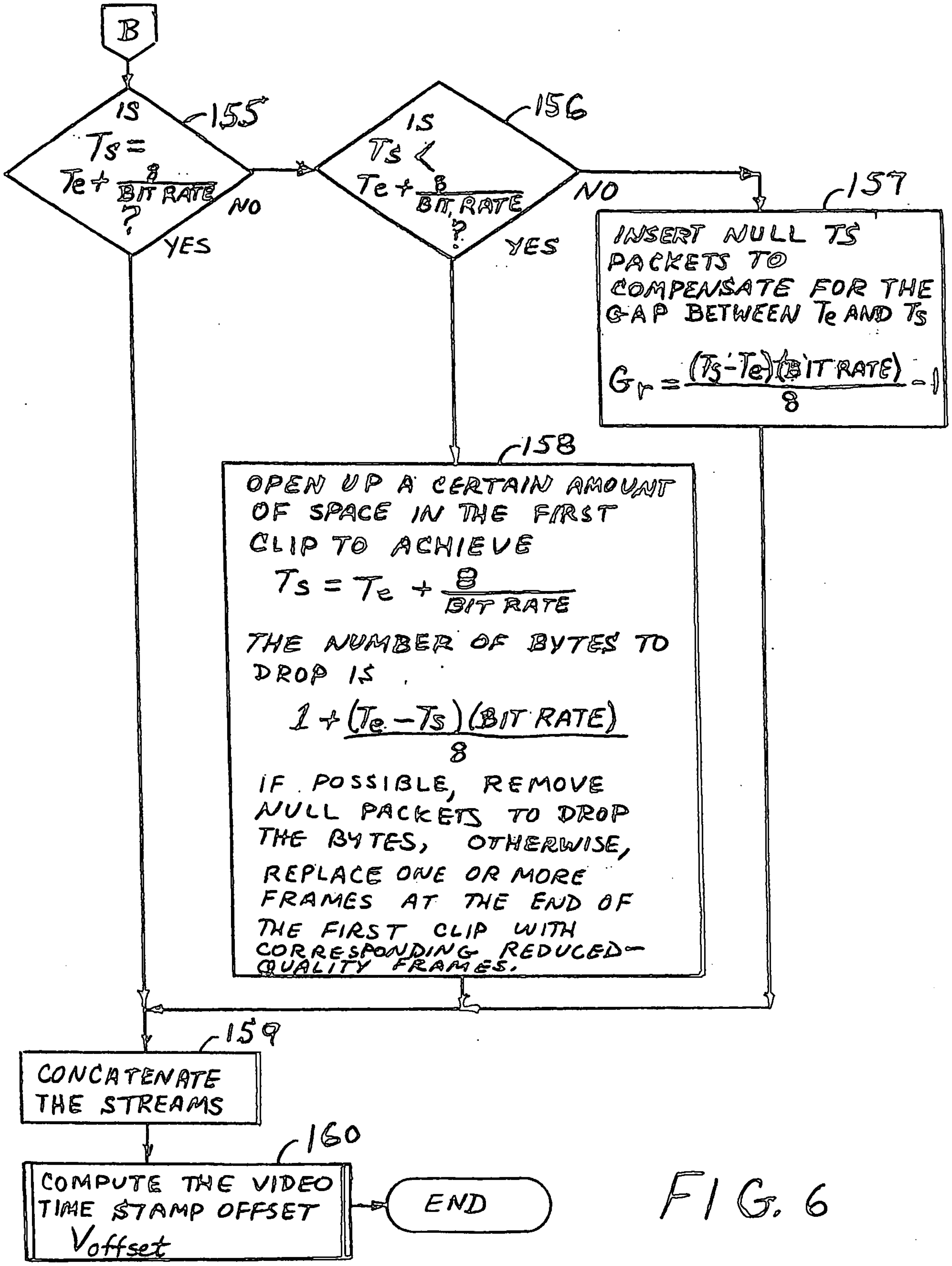

B
IS $T_s = T_e + \frac{8}{\text{BIT RATE}}$?
155
NO
YES
IS $T_s < T_e + \frac{8}{\text{BIT RATE}}$?
156
NO
YES
157
INSERT NULL TS PACKETS TO COMPENSATE FOR THE GAP BETWEEN T_e AND T_s
$G_r = \frac{(T_s - T_e)(\text{BIT RATE})}{8} - 1$
158
OPEN UP A CERTAIN AMOUNT OF SPACE IN THE FIRST CLIP TO ACHIEVE
$T_s = T_e + \frac{8}{\text{BIT RATE}}$
THE NUMBER OF BYTES TO DROP IS
$1 + \frac{(T_e - T_s)(\text{BIT RATE})}{8}$
IF POSSIBLE, REMOVE NULL PACKETS TO DROP THE BYTES, OTHERWISE, REPLACE ONE OR MORE FRAMES AT THE END OF THE FIRST CLIP WITH CORRESPONDING REDUCED-QUALITY FRAMES.
159
CONCATENATE THE STREAMS
160
COMPUTE THE VIDEO TIME STAMP OFFSET V_{offset}
END

FIG. 6

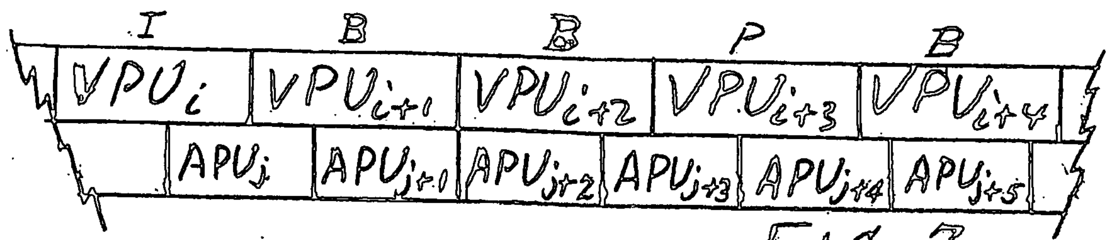


FIG. 7

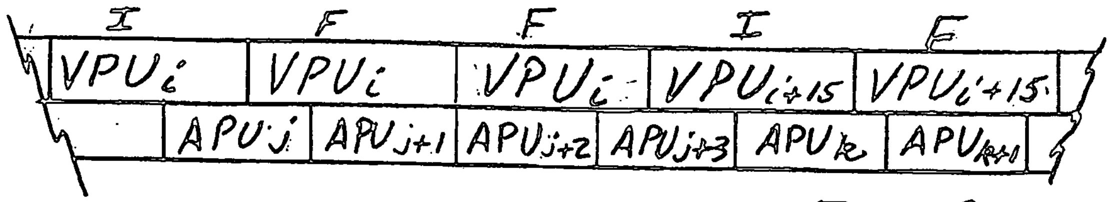


FIG. 8

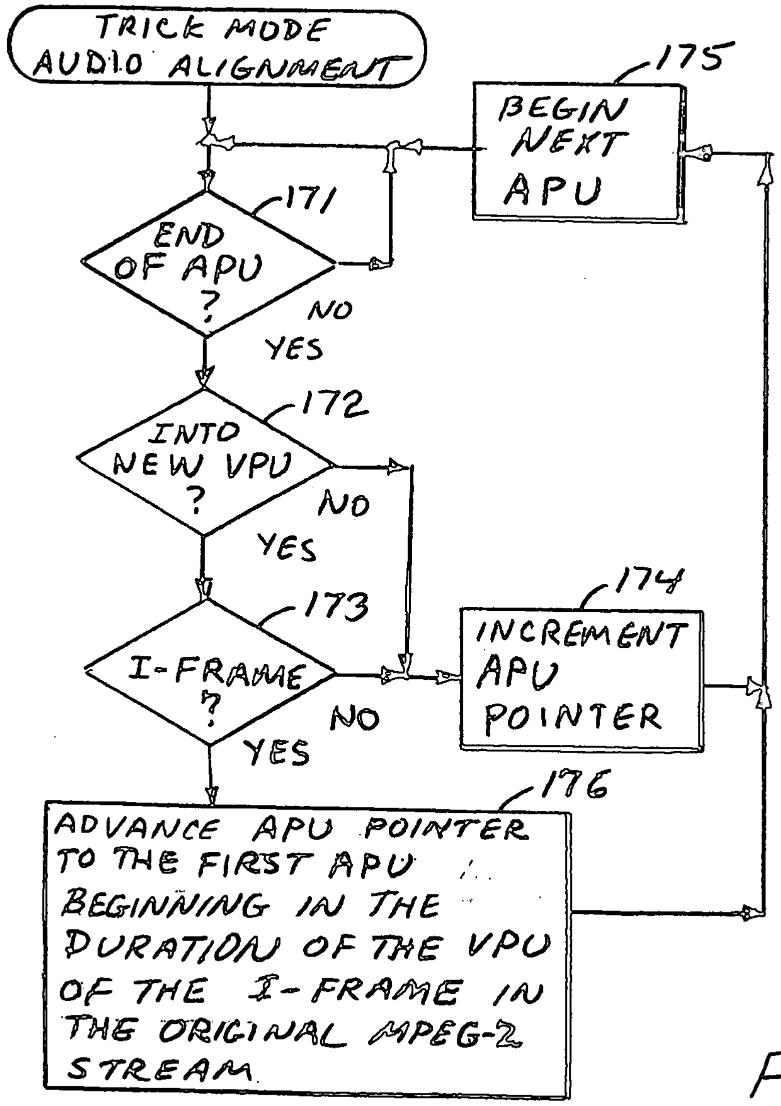
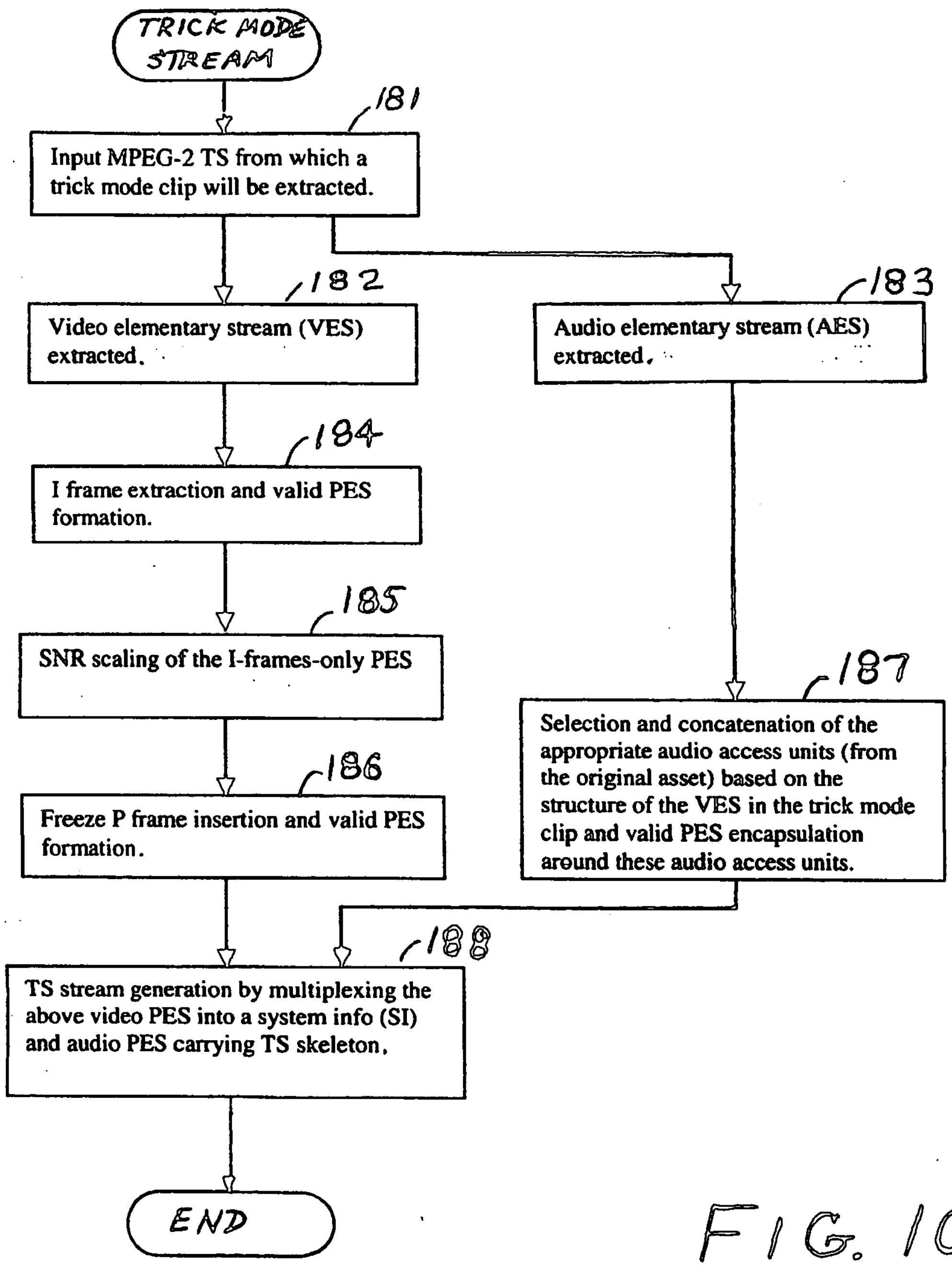
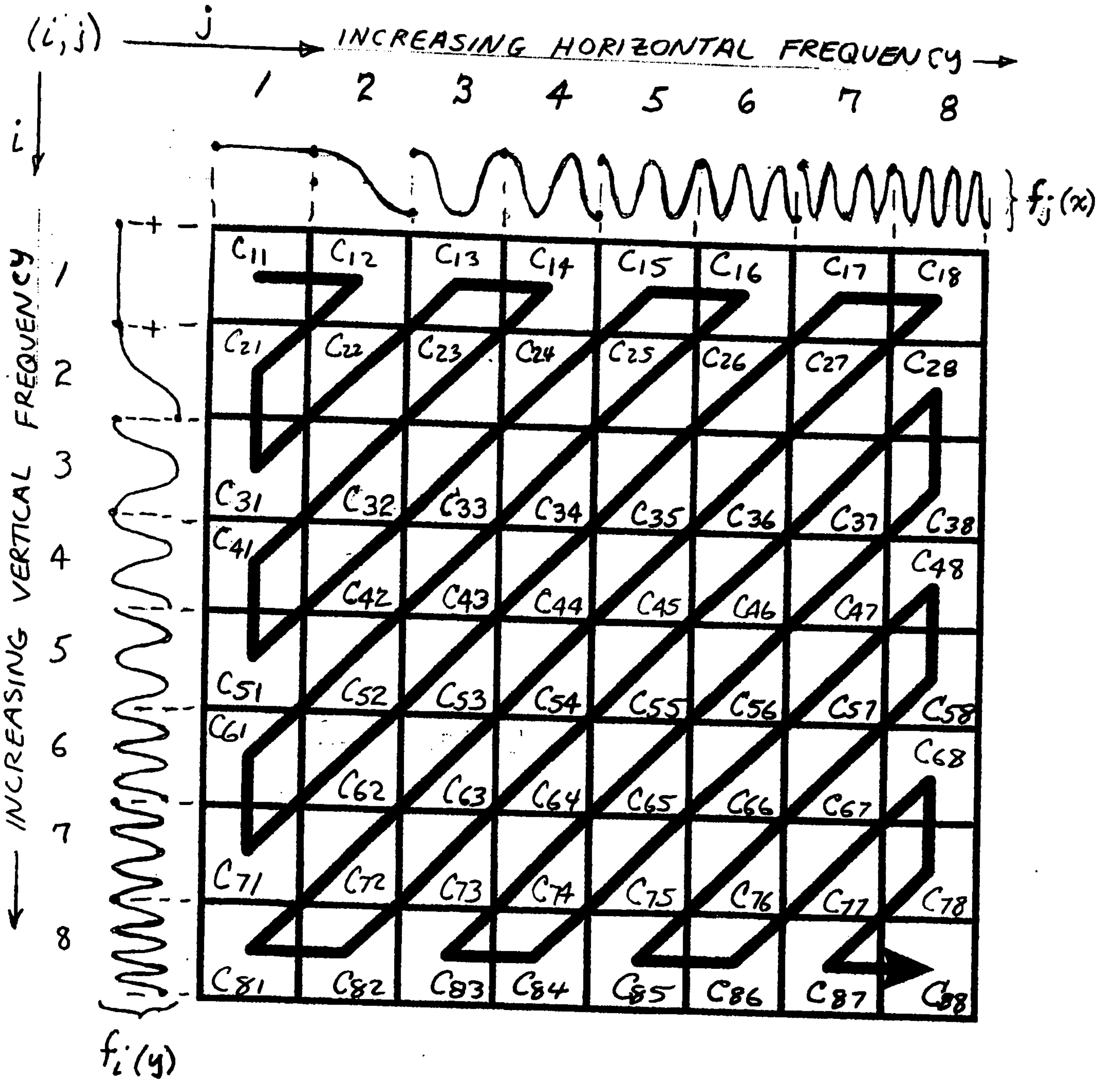

TRICK MODE AUDIO ALIGNMENT
171
END OF APU ?
NO
YES
172
INTO NEW VPU ?
NO
YES
173
I-FRAME ?
NO
YES
175
BEGIN NEXT APU
174
INCREMENT APU POINTER
176
ADVANCE APU POINTER TO THE FIRST APU BEGINNING IN THE DURATION OF THE VPU OF THE I-FRAME IN THE ORIGINAL MPEG-2 STREAM

FIG. 9



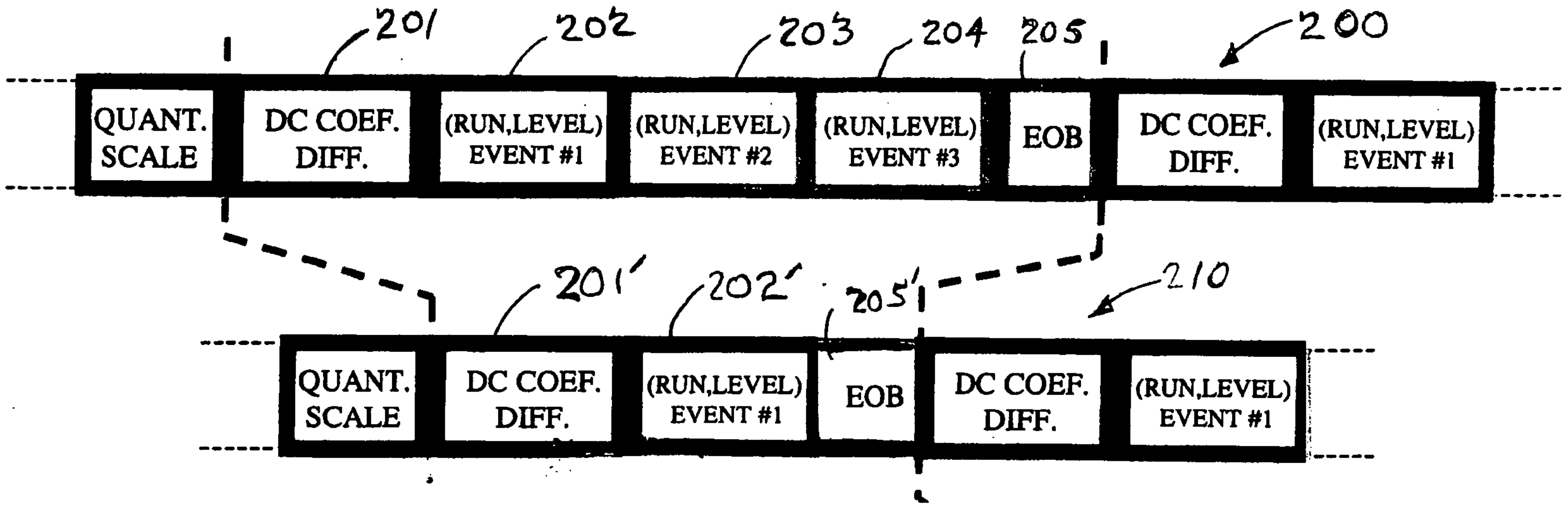
TRICK MODE STREAM
181
Input MPEG-2 TS from which a trick mode clip will be extracted.
182
Video elementary stream (VES) extracted.
183
Audio elementary stream (AES) extracted.
184
I frame extraction and valid PES formation.
185
SNR scaling of the I-frames-only PES
186
Freeze P frame insertion and valid PES formation.
187
Selection and concatenation of the appropriate audio access units (from the original asset) based on the structure of the VES in the trick mode clip and valid PES encapsulation around these audio access units.
188
TS stream generation by multiplexing the above video PES into a system info (SI) and audio PES carrying TS skeleton.
END

FIG. 10



(i,j)
j
INCREASING HORIZONTAL FREQUENCY
1 2 3 4 5 6 7 8
i
$f_j(x)$
INCREASING VERTICAL FREQUENCY
1 2 3 4 5 6 7 8
$f_i(y)$
C_{11} C_{12} C_{13} C_{14} C_{15} C_{16} C_{17} C_{18}
C_{21} C_{22} C_{23} C_{24} C_{25} C_{26} C_{27} C_{28}
C_{31} C_{32} C_{33} C_{34} C_{35} C_{36} C_{37} C_{38}
C_{41} C_{42} C_{43} C_{44} C_{45} C_{46} C_{47} C_{48}
C_{51} C_{52} C_{53} C_{54} C_{55} C_{56} C_{57} C_{58}
C_{61} C_{62} C_{63} C_{64} C_{65} C_{66} C_{67} C_{68}
C_{71} C_{72} C_{73} C_{74} C_{75} C_{76} C_{77} C_{78}
C_{81} C_{82} C_{83} C_{84} C_{85} C_{86} C_{87} C_{88}

FIG. 11
(PRIOR ART)



200
201
202
203
204
205
QUANT. SCALE
DC COEF. DIFF.
(RUN,LEVEL) EVENT #1
(RUN,LEVEL) EVENT #2
(RUN,LEVEL) EVENT #3
EOB
DC COEF. DIFF.
(RUN,LEVEL) EVENT #1
210
201'
202'
205'
QUANT. SCALE
DC COEF. DIFF.
(RUN,LEVEL) EVENT #1
EOB
DC COEF. DIFF.
(RUN,LEVEL) EVENT #1

FIG. 12

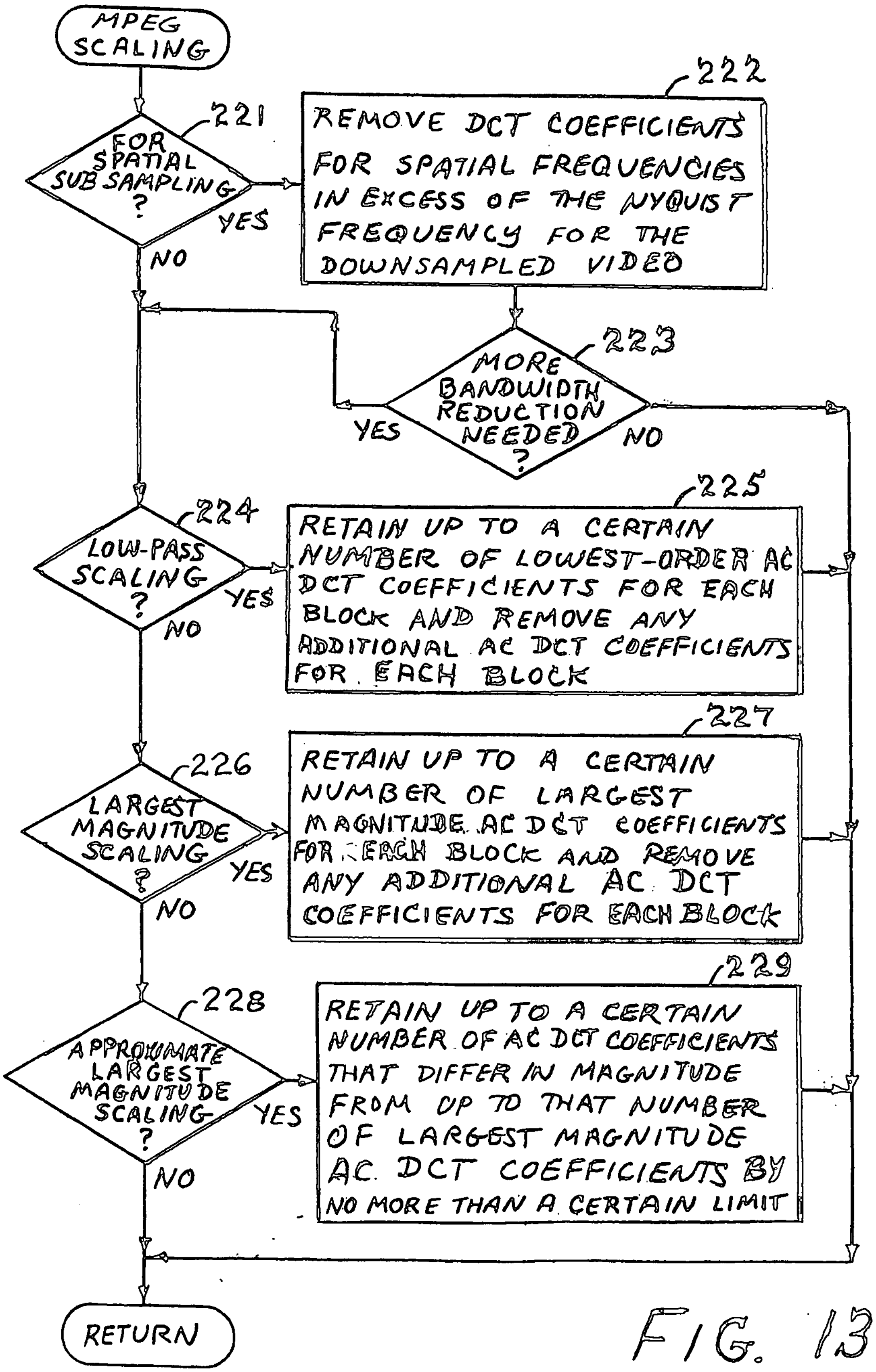
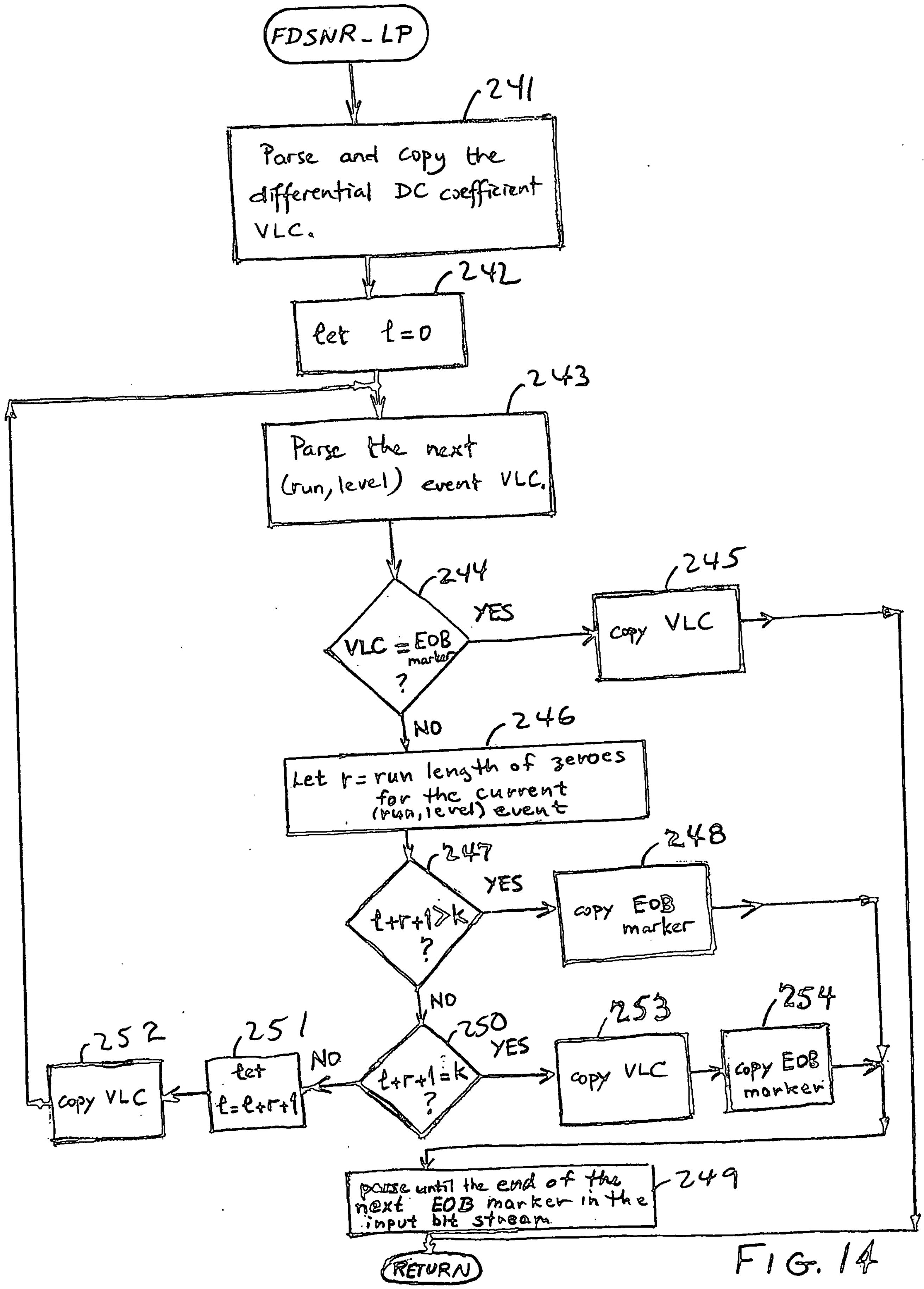

MPEG SCALING
221
FOR SPATIAL SUBSAMPLING ?
YES
NO
222
REMOVE DCT COEFFICIENTS FOR SPATIAL FREQUENCIES IN EXCESS OF THE NYQUIST FREQUENCY FOR THE DOWNSAMPLED VIDEO
223
MORE BANDWIDTH REDUCTION NEEDED ?
YES
NO
224
LOW-PASS SCALING ?
YES
NO
225
RETAIN UP TO A CERTAIN NUMBER OF LOWEST-ORDER AC DCT COEFFICIENTS FOR EACH BLOCK AND REMOVE ANY ADDITIONAL AC DCT COEFFICIENTS FOR EACH BLOCK
226
LARGEST MAGNITUDE SCALING ?
YES
NO
227
RETAIN UP TO A CERTAIN NUMBER OF LARGEST MAGNITUDE AC DCT COEFFICIENTS FOR EACH BLOCK AND REMOVE ANY ADDITIONAL AC DCT COEFFICIENTS FOR EACH BLOCK
228
APPROXIMATE LARGEST MAGNITUDE SCALING ?
YES
NO
229
RETAIN UP TO A CERTAIN NUMBER OF AC DCT COEFFICIENTS THAT DIFFER IN MAGNITUDE FROM UP TO THAT NUMBER OF LARGEST MAGNITUDE AC DCT COEFFICIENTS BY NO MORE THAN A CERTAIN LIMIT
RETURN

FIG. 13



FDSNR_LP
241
Parse and copy the differential DC coefficient VLC.
242
let ℓ=0
243
Parse the next (run, level) event VLC.
244
VLC = EOB marker ?
YES
245
copy VLC
NO
246
Let r = run length of zeroes for the current (run, level) event
247
ℓ+r+1>k ?
YES
248
copy EOB marker
NO
250
ℓ+r+1=k ?
YES
253
copy VLC
254
copy EOB marker
NO
251
let ℓ=ℓ+r+1
252
copy VLC
249
parse until the end of the next EOB marker in the input bit stream
RETURN

FIG. 14

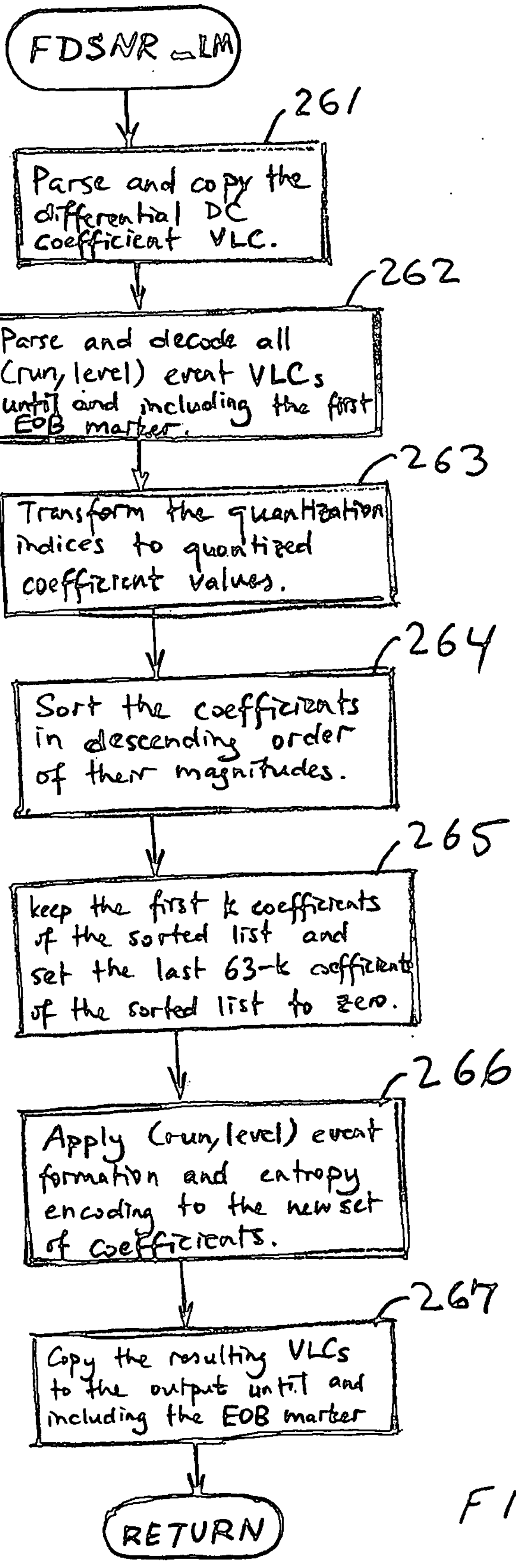
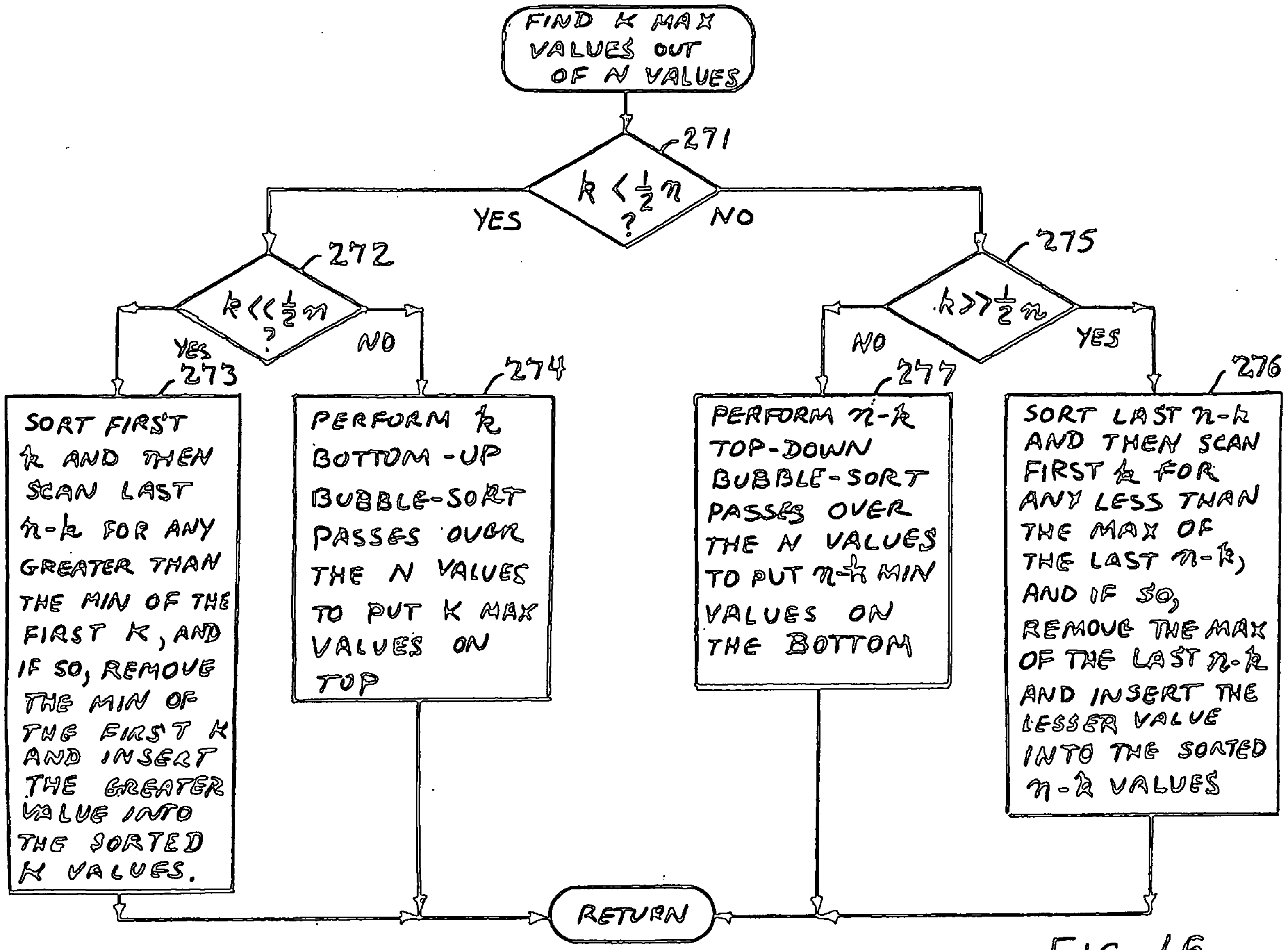
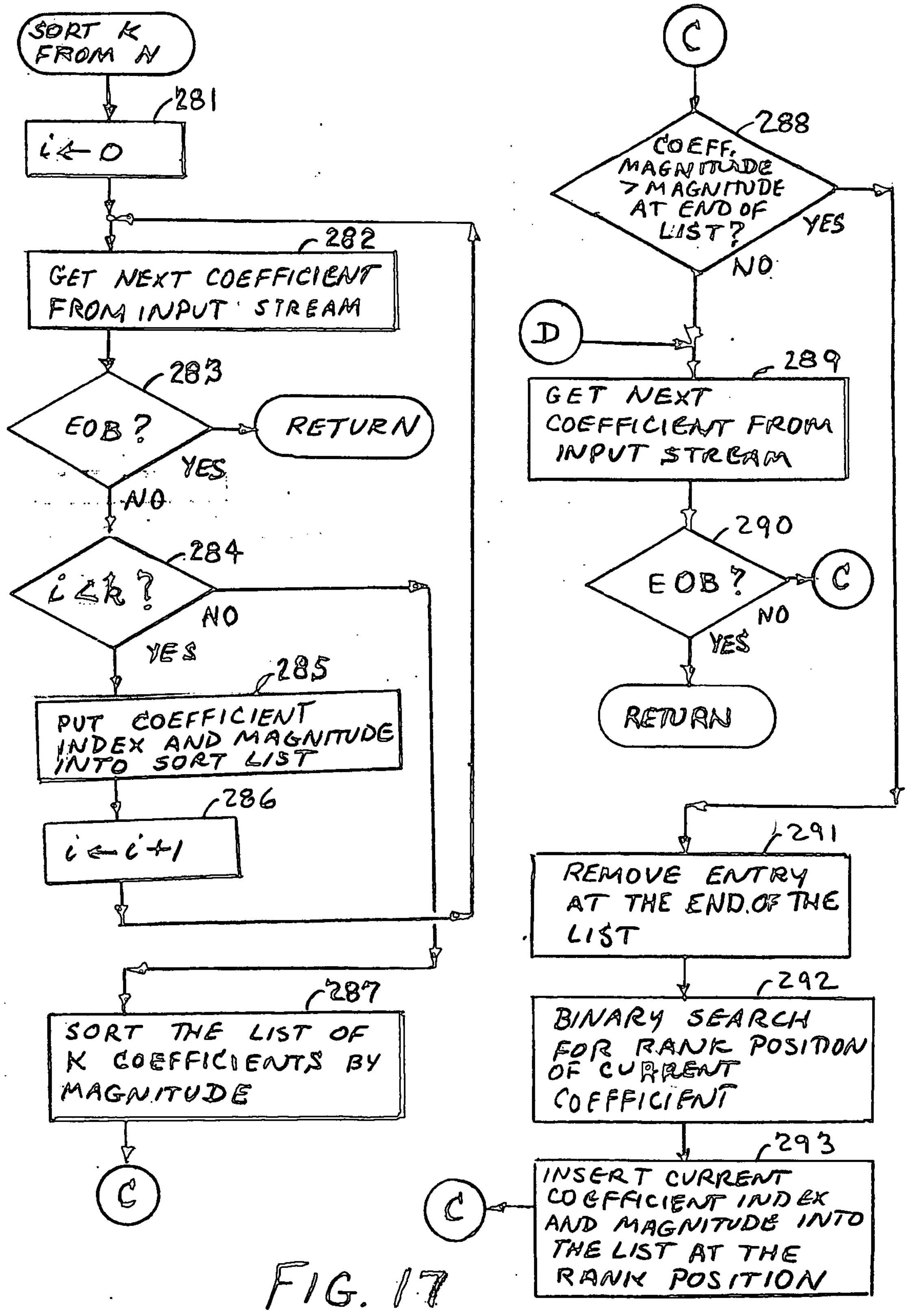

FDSNR_LM
261
Parse and copy the differential DC coefficient VLC.
262
Parse and decode all (run, level) event VLCs until and including the first EOB marker.
263
Transform the quantization indices to quantized coefficient values.
264
Sort the coefficients in descending order of their magnitudes.
265
keep the first k coefficients of the sorted list and set the last 63-k coefficients of the sorted list to zero.
266
Apply (run, level) event formation and entropy encoding to the new set of coefficients.
267
Copy the resulting VLCs to the output until and including the EOB marker
RETURN

FIG. 15



FIND K MAX VALUES OUT OF N VALUES
271
$k < \frac{1}{2}n$?
YES
NO
272
$k << \frac{1}{2}n$?
YES
NO
273
SORT FIRST k AND THEN SCAN LAST n-k FOR ANY GREATER THAN THE MIN OF THE FIRST K, AND IF SO, REMOVE THE MIN OF THE FIRST K AND INSERT THE GREATER VALUE INTO THE SORTED K VALUES.
274
PERFORM k BOTTOM-UP BUBBLE-SORT PASSES OVER THE N VALUES TO PUT K MAX VALUES ON TOP
275
$k >> \frac{1}{2}n$
NO
YES
277
PERFORM n-k TOP-DOWN BUBBLE-SORT PASSES OVER THE N VALUES TO PUT n-k MIN VALUES ON THE BOTTOM
276
SORT LAST n-k AND THEN SCAN FIRST k FOR ANY LESS THAN THE MAX OF THE LAST n-k, AND IF SO, REMOVE THE MAX OF THE LAST n-k AND INSERT THE LESSER VALUE INTO THE SORTED n-k VALUES
RETURN

FIG. 16



SORT K FROM N
281
i ← 0
282
GET NEXT COEFFICIENT FROM INPUT STREAM
283
EOB?
YES
RETURN
NO
284
i < k?
NO
YES
285
PUT COEFFICIENT INDEX AND MAGNITUDE INTO SORT LIST
286
i ← i+1
287
SORT THE LIST OF K COEFFICIENTS BY MAGNITUDE
C
C
288
COEFF. MAGNITUDE > MAGNITUDE AT END OF LIST?
YES
NO
D
289
GET NEXT COEFFICIENT FROM INPUT STREAM
290
EOB?
NO
C
YES
RETURN
291
REMOVE ENTRY AT THE END OF THE LIST
292
BINARY SEARCH FOR RANK POSITION OF CURRENT COEFFICIENT
293
INSERT CURRENT COEFFICIENT INDEX AND MAGNITUDE INTO THE LIST AT THE RANK POSITION
C

FIG. 17

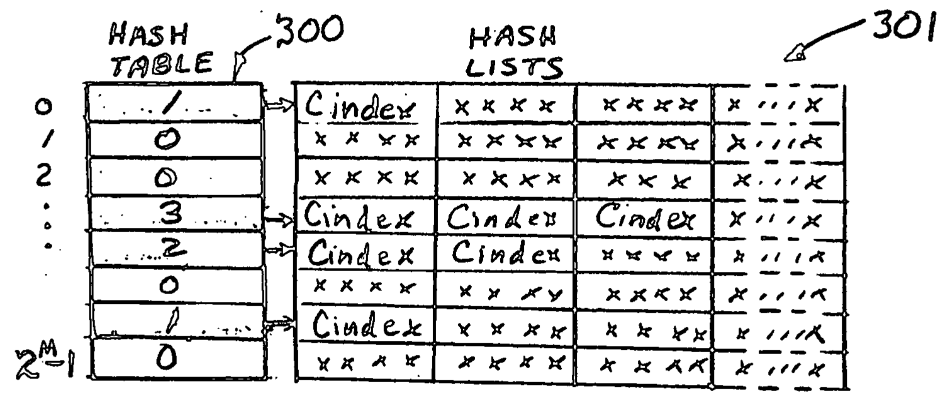


FIG. 18

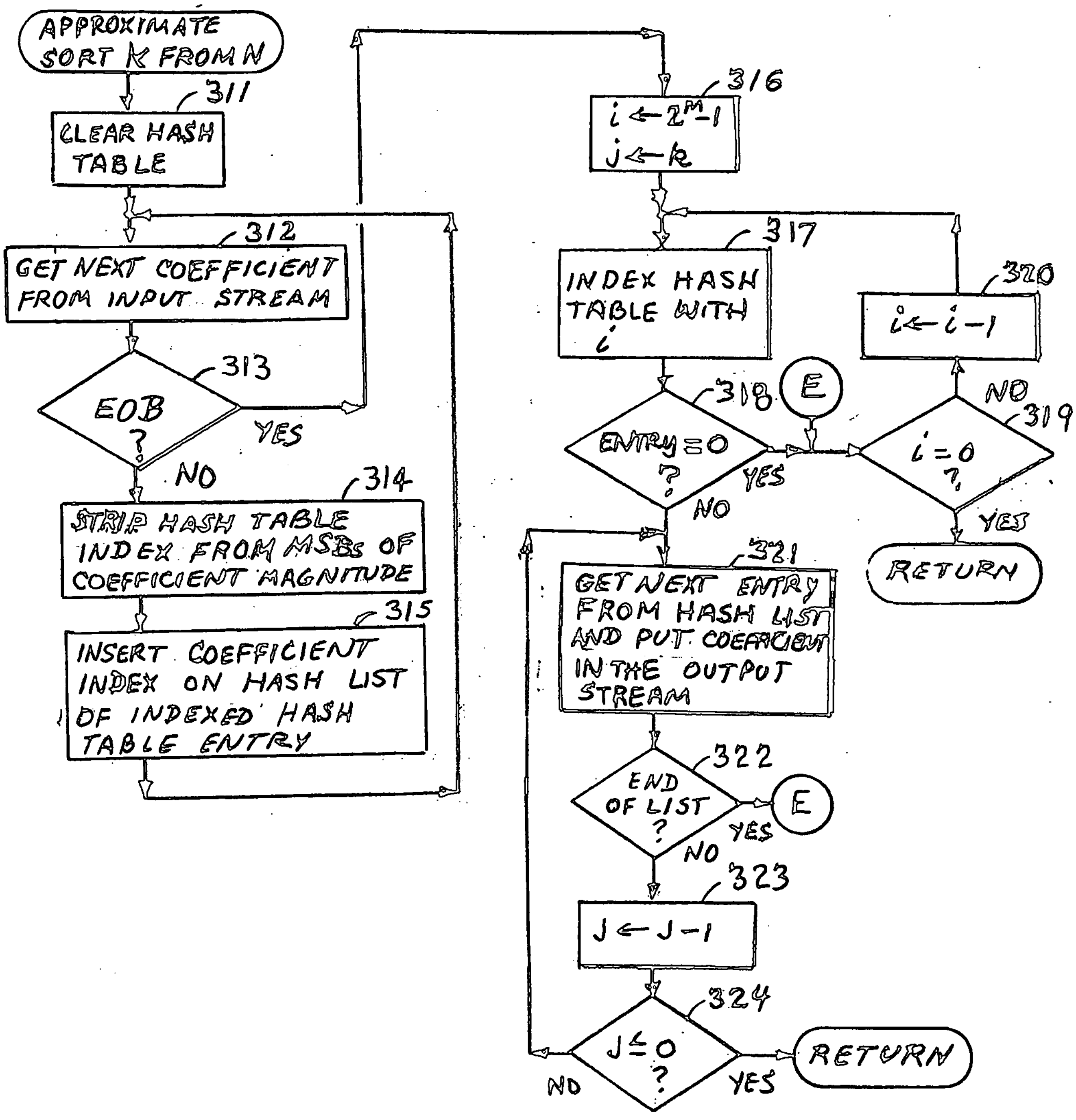
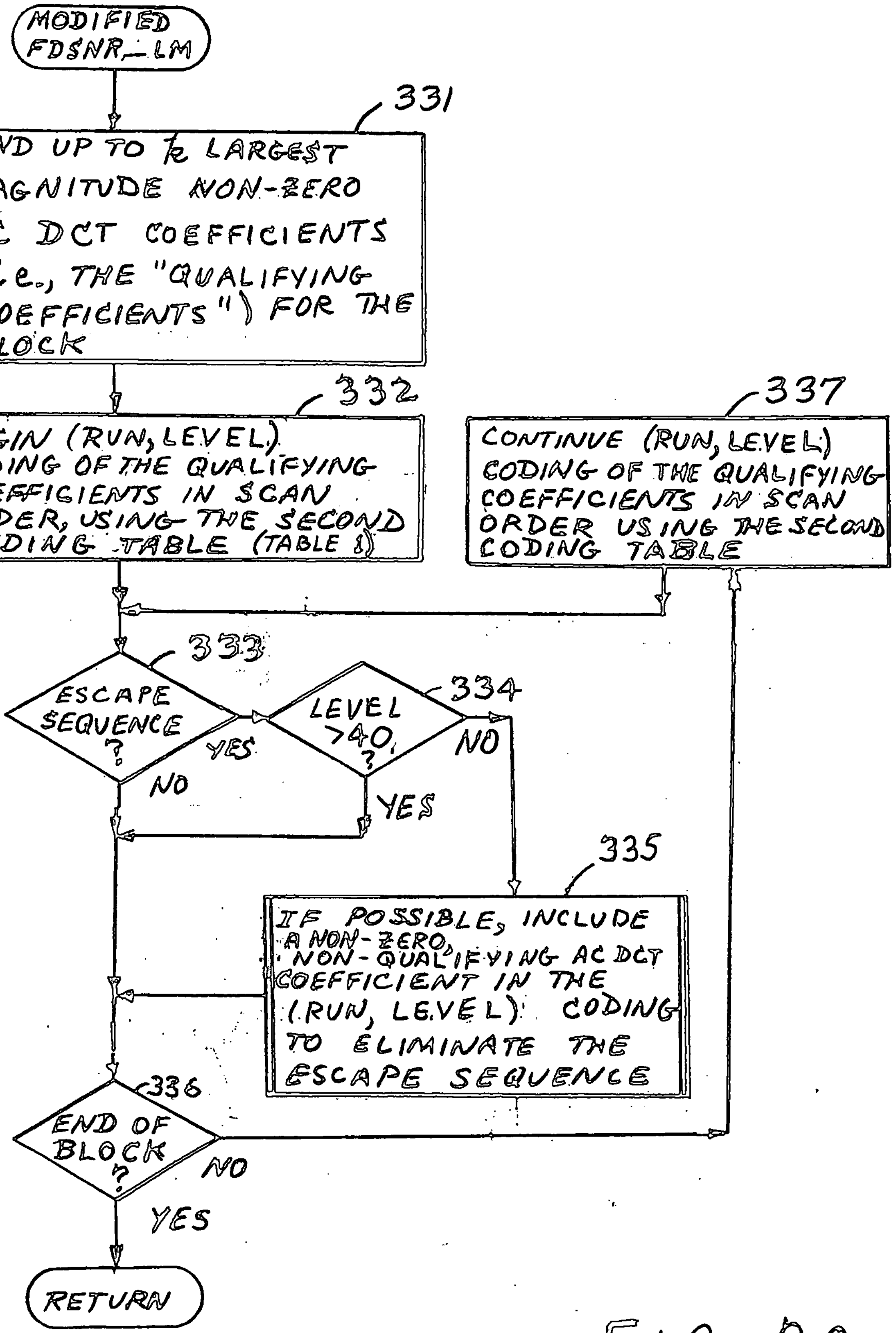

APPROXIMATE SORT k FROM N
311
CLEAR HASH TABLE
312
GET NEXT COEFFICIENT FROM INPUT STREAM
313
EOB ?
YES
NO
314
STRIP HASH TABLE INDEX FROM MSBs OF COEFFICIENT MAGNITUDE
315
INSERT COEFFICIENT INDEX ON HASH LIST OF INDEXED HASH TABLE ENTRY
316
i ← 2^M - 1
j ← k
317
INDEX HASH TABLE WITH i
318
E
ENTRY = 0 ?
YES
NO
319
i = 0 ?
NO
YES
320
i ← i - 1
RETURN
321
GET NEXT ENTRY FROM HASH LIST AND PUT COEFFICIENT IN THE OUTPUT STREAM
322
END OF LIST ?
YES
E
NO
323
J ← J - 1
324
J ≤ 0 ?
NO
YES
RETURN

FIG. 19



MODIFIED FDSNR_LM
331
FIND UP TO k LARGEST MAGNITUDE NON-ZERO AC DCT COEFFICIENTS (i.e., THE "QUALIFYING COEFFICIENTS") FOR THE BLOCK
332
BEGIN (RUN, LEVEL) CODING OF THE QUALIFYING COEFFICIENTS IN SCAN ORDER, USING THE SECOND CODING TABLE (TABLE 1)
337
CONTINUE (RUN, LEVEL) CODING OF THE QUALIFYING COEFFICIENTS IN SCAN ORDER USING THE SECOND CODING TABLE
333
ESCAPE SEQUENCE ?
YES
NO
334
LEVEL >40 ?
NO
YES
335
IF POSSIBLE, INCLUDE A NON-ZERO, NON-QUALIFYING AC DCT COEFFICIENT IN THE (RUN, LEVEL) CODING TO ELIMINATE THE ESCAPE SEQUENCE
336
END OF BLOCK ?
NO
YES
RETURN

FIG. 20

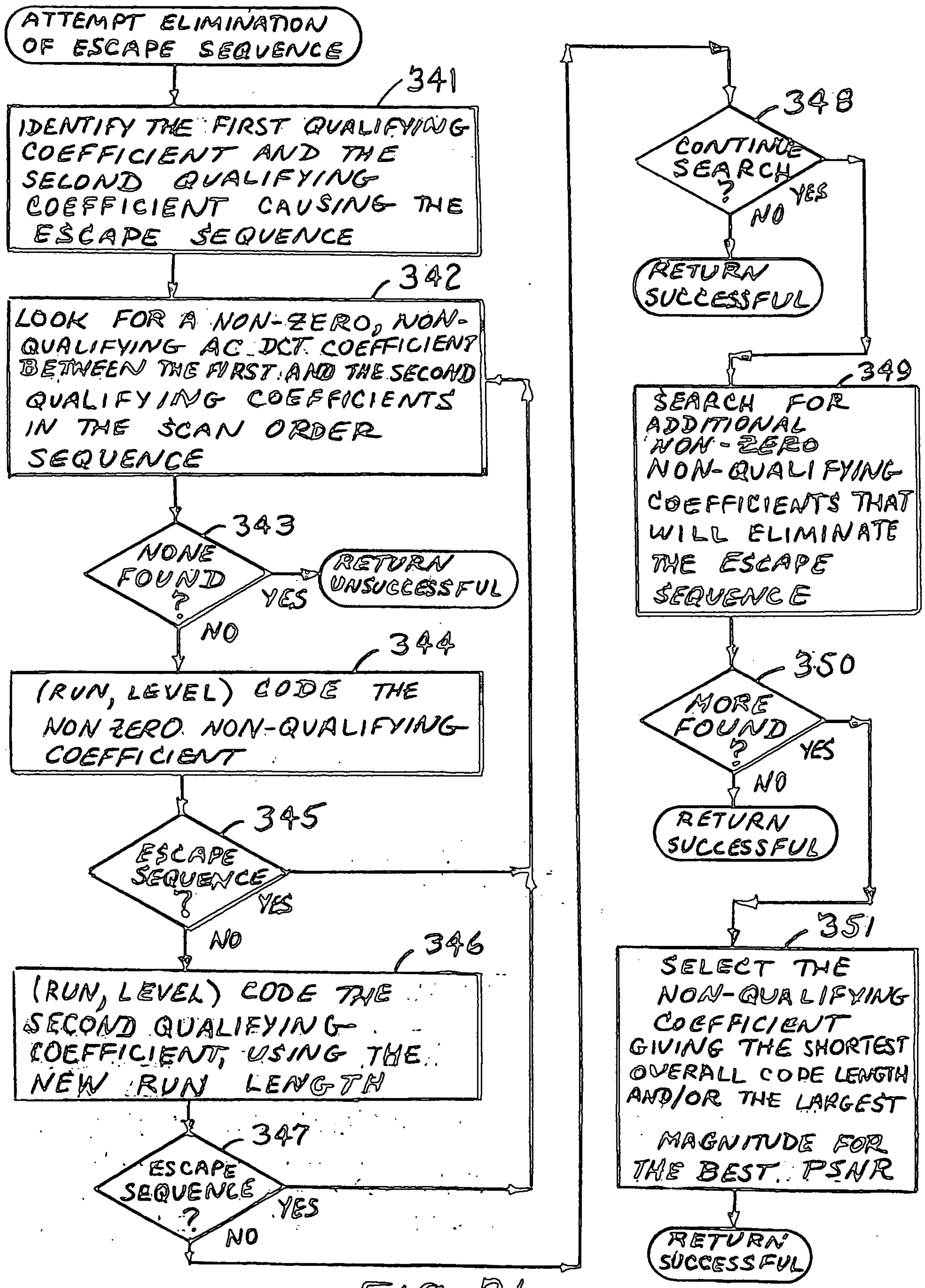

ATTEMPT ELIMINATION OF ESCAPE SEQUENCE
341
IDENTIFY THE FIRST QUALIFYING COEFFICIENT AND THE SECOND QUALIFYING COEFFICIENT CAUSING THE ESCAPE SEQUENCE
342
LOOK FOR A NON-ZERO, NON-QUALIFYING AC DCT COEFFICIENT BETWEEN THE FIRST AND THE SECOND QUALIFYING COEFFICIENTS IN THE SCAN ORDER SEQUENCE
343
NONE FOUND ?
YES
RETURN UNSUCCESSFUL
NO
344
(RUN, LEVEL) CODE THE NON ZERO NON-QUALIFYING COEFFICIENT
345
ESCAPE SEQUENCE ?
YES
NO
346
(RUN, LEVEL) CODE THE SECOND QUALIFYING COEFFICIENT, USING THE NEW RUN LENGTH
347
ESCAPE SEQUENCE ?
YES
NO
348
CONTINUE SEARCH ?
YES
NO
RETURN SUCCESSFUL
349
SEARCH FOR ADDITIONAL NON-ZERO NON-QUALIFYING COEFFICIENTS THAT WILL ELIMINATE THE ESCAPE SEQUENCE
350
MORE FOUND ?
YES
NO
RETURN SUCCESSFUL
351
SELECT THE NON-QUALIFYING COEFFICIENT GIVING THE SHORTEST OVERALL CODE LENGTH AND/OR THE LARGEST MAGNITUDE FOR THE BEST PSNR
RETURN SUCCESSFUL

FIG. 21

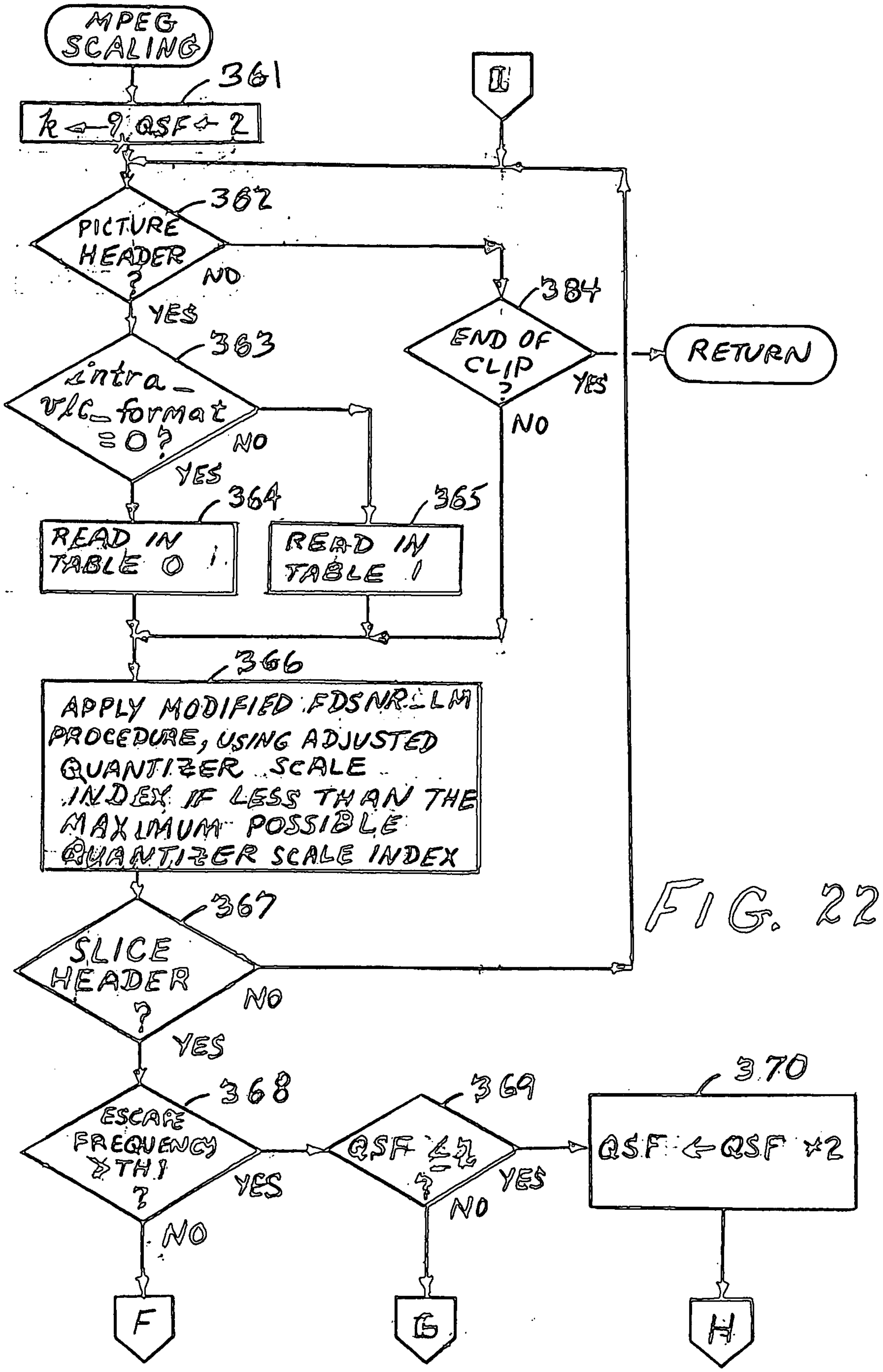

MPEG SCALING
361
k ← 9, QSF ← 2
D
362
PICTURE HEADER ?
NO
YES
384
END OF CLIP ?
YES
NO
RETURN
363
intra_vlc_format = 0 ?
NO
YES
364
READ IN TABLE 0
365
READ IN TABLE 1
366
APPLY MODIFIED FDSNR_LM PROCEDURE, USING ADJUSTED QUANTIZER SCALE INDEX IF LESS THAN THE MAXIMUM POSSIBLE QUANTIZER SCALE INDEX
367
SLICE HEADER ?
NO
YES
368
ESCAPE FREQUENCY ≥ TH1 ?
YES
NO
369
QSF ≤ 4 ?
YES
NO
370
QSF ← QSF * 2
F
G
H

FIG. 22

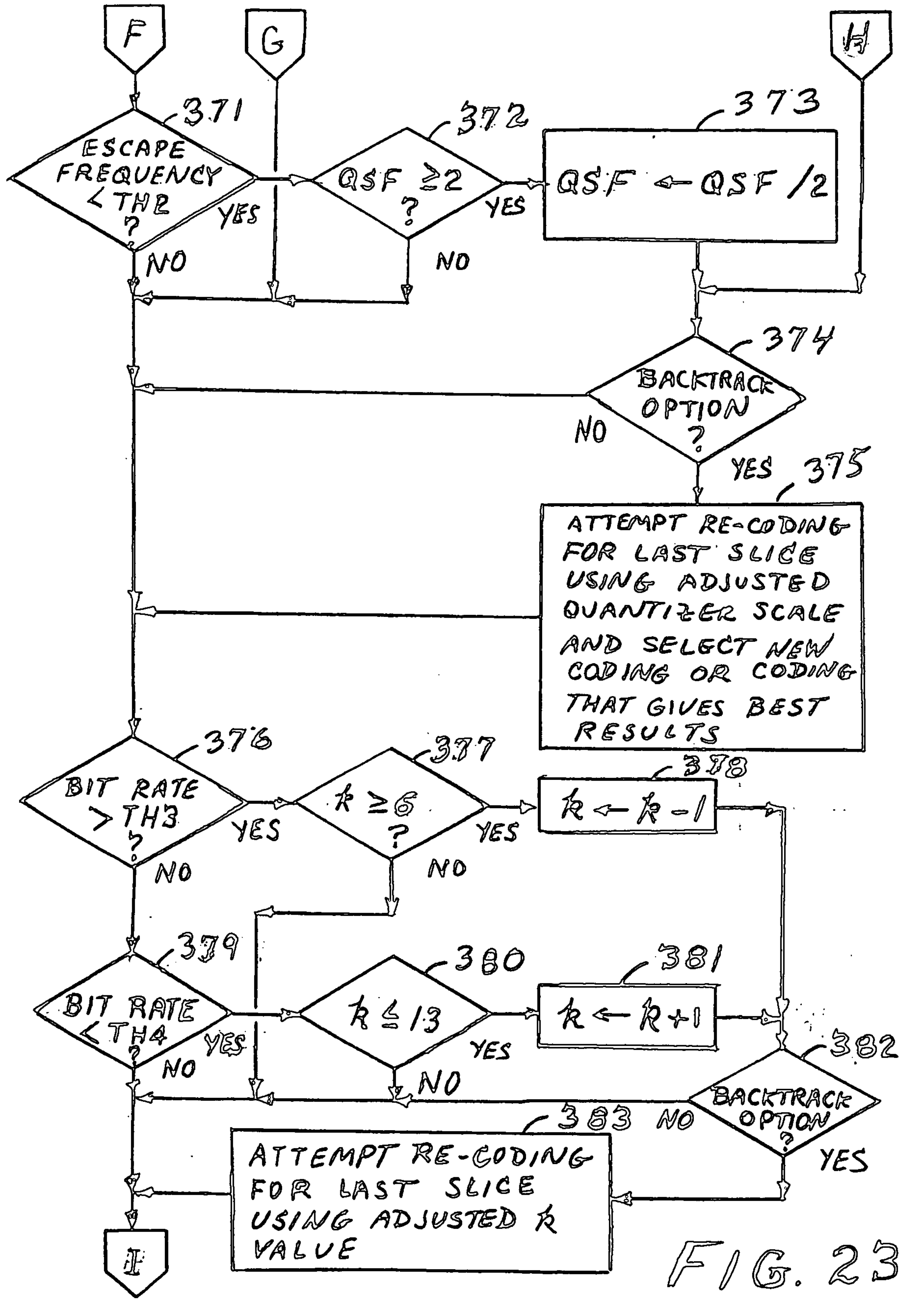

F
G
H
371
ESCAPE FREQUENCY < TH2 ?
YES
NO
372
QSF ≥ 2 ?
YES
NO
373
QSF ← QSF / 2
374
BACKTRACK OPTION ?
NO
YES
375
ATTEMPT RE-CODING FOR LAST SLICE USING ADJUSTED QUANTIZER SCALE AND SELECT NEW CODING OR CODING THAT GIVES BEST RESULTS
376
BIT RATE > TH3 ?
YES
NO
377
k ≥ 6 ?
YES
NO
378
k ← k - 1
379
BIT RATE < TH4 ?
YES
NO
380
k ≤ 13
YES
NO
381
k ← k + 1
382
BACKTRACK OPTION ?
NO
YES
383
ATTEMPT RE-CODING FOR LAST SLICE USING ADJUSTED k VALUE
I

FIG. 23

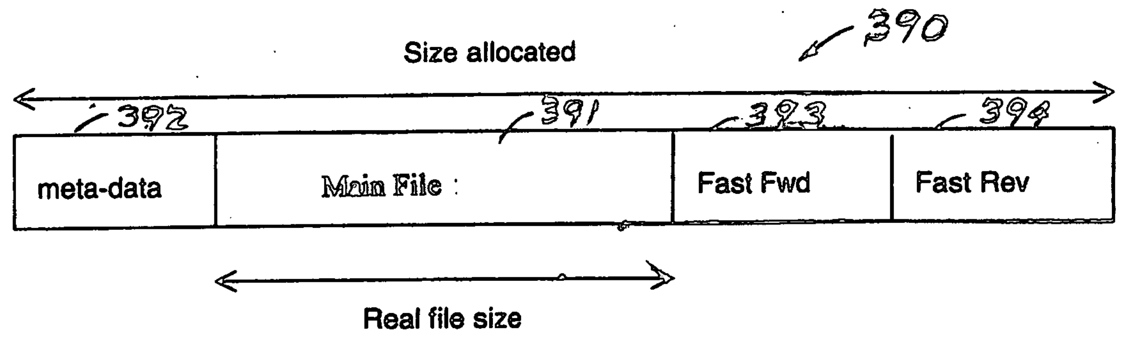

390
Size allocated
392
391
393
394
meta-data
Main File
Fast Fwd
Fast Rev
Real file size

FIG. 24

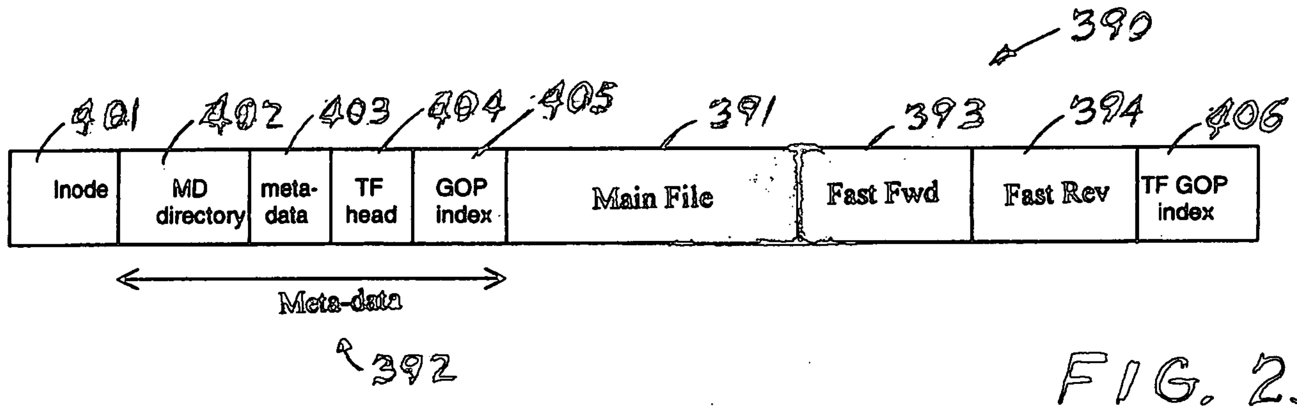

390
401
402
403
404
405
391
393
394
406
Inode
MD directory
meta-data
TF head
GOP index
Main File
Fast Fwd
Fast Rev
TF GOP index
Meta-data
392

FIG. 25

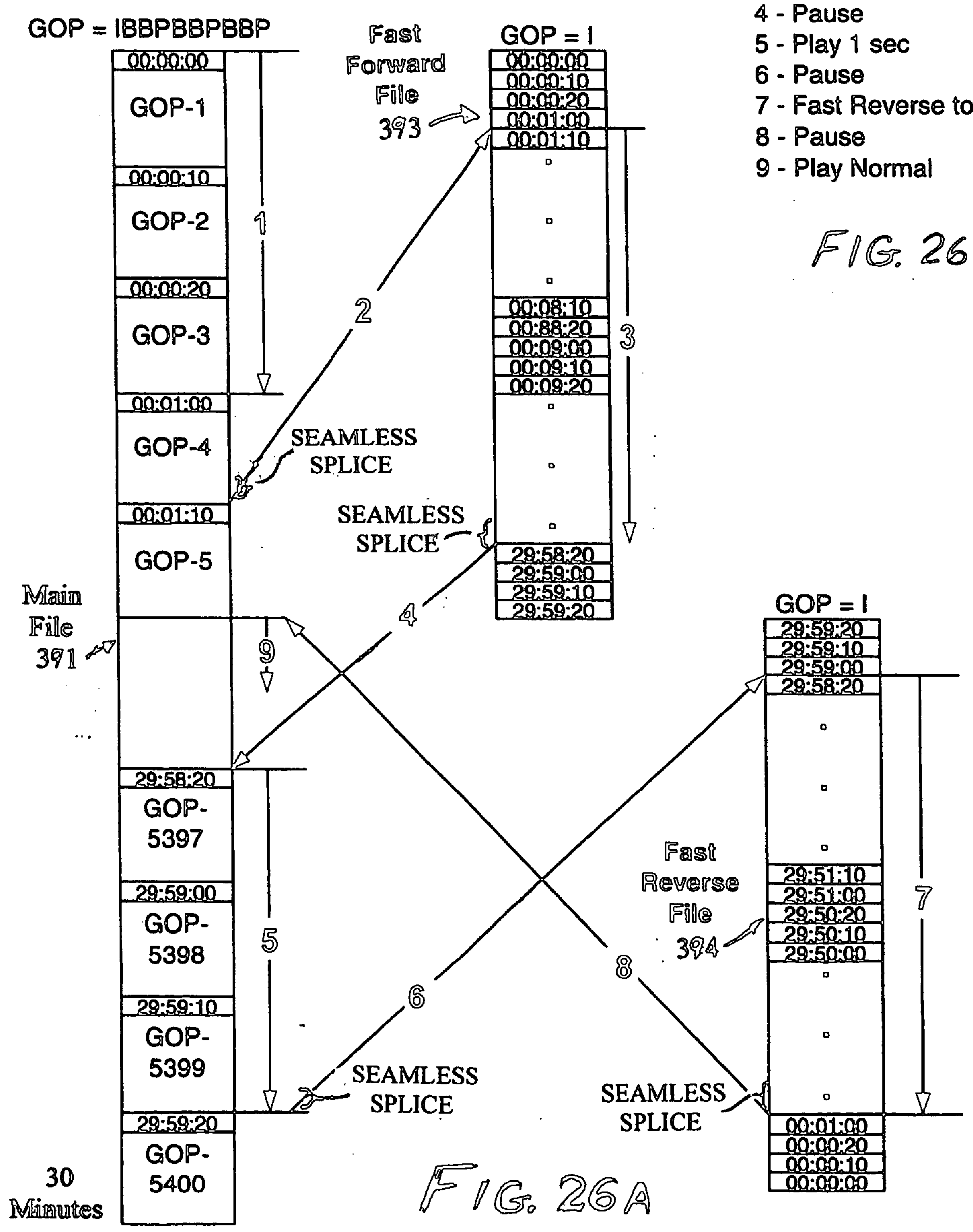


FIG. 26A

1 - Play from start 1 sec
2 - Pause
3 - Fast Forward to 29 min
4 - Pause
5 - Play 1 sec
6 - Pause
7 - Fast Reverse to 1 sec
8 - Pause
9 - Play Normal

FIG. 26B

	READ	WRITE
Copy of the asset with all the data	EMPEG2	EMPEG2
Copy only the main asset	RAW	MPEG2
Archive	EMPEG2	EMPEG2
Play	MPEG2	
Record		MPEG2

FIG. 27

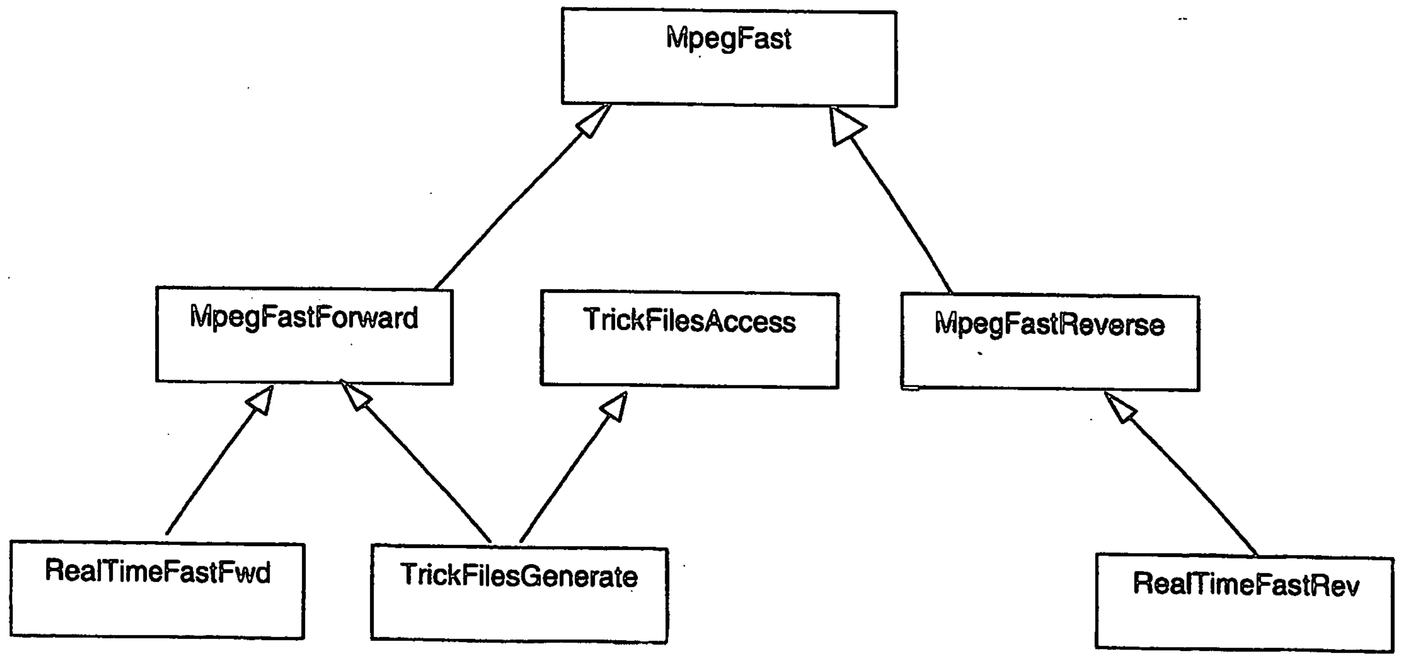


FIG. 28

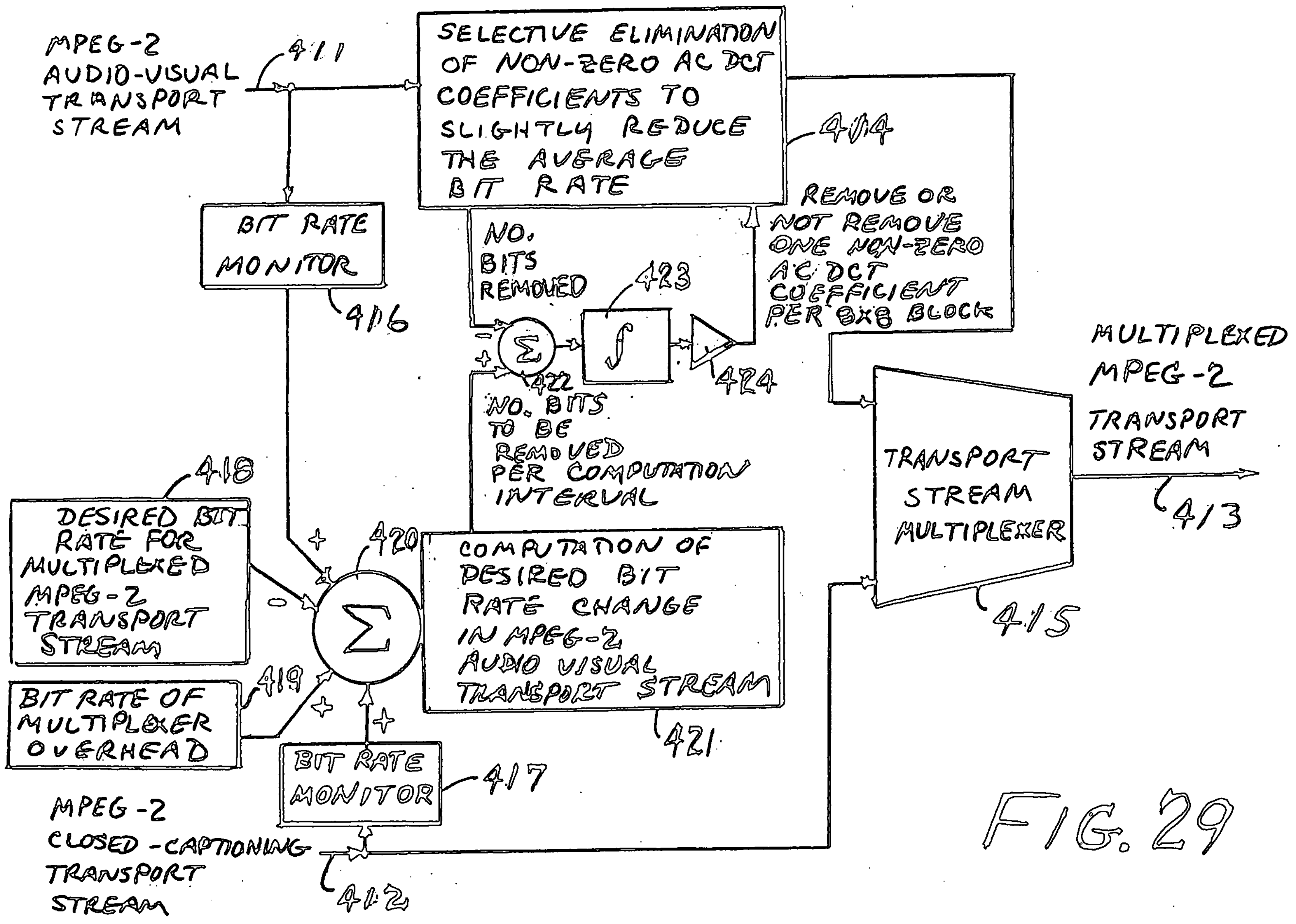

MPEG-2 AUDIO-VISUAL TRANSPORT STREAM
411
SELECTIVE ELIMINATION OF NON-ZERO AC DCT COEFFICIENTS TO SLIGHTLY REDUCE THE AVERAGE BIT RATE
414
BIT RATE MONITOR
416
NO. BITS REMOVED
423
REMOVE OR NOT REMOVE ONE NON-ZERO AC DCT COEFFICIENT PER 8x8 BLOCK
422
424
NO. BITS TO BE REMOVED PER COMPUTATION INTERVAL
MULTIPLEXED MPEG-2 TRANSPORT STREAM
TRANSPORT STREAM MULTIPLEXER
413
415
418
DESIRED BIT RATE FOR MULTIPLEXED MPEG-2 TRANSPORT STREAM
420
COMPUTATION OF DESIRED BIT RATE CHANGE IN MPEG-2 AUDIO VISUAL TRANSPORT STREAM
421
BIT RATE OF MULTIPLEXER OVERHEAD
419
BIT RATE MONITOR
417
MPEG-2 CLOSED-CAPTIONING TRANSPORT STREAM
412

FIG. 29